J. Plant Production, Mansoura Univ., Vol. 4 (6): 943 - 956, 2013

IMPROVING EGYPTIAN COTTON USING F_2 TRIALLEL CROSSES

Abd El-Bary, A. M. R.
Cotton Research Institute., Agricultural Research Center , Giza , Egypt

ABSTRACT

The aim of this investigation is to determine combining ability estimates for yield, yield components traits and some fiber properties in cotton. The genetic materials used in the present study included five cotton lines and their 30 F_2 three-way crosses. All these lines belong to the species *Gossypium barbadense* L. In 2010 growing season, these genotypes were evaluated in a field trial experiment at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate. The following traits were estimated: seed cotton yield/plant, lint yield/plant, boll weight, lint percentage, fiber strength, fiber fineness and upper half mean.

The results showed that the performances of most the F_2 three-way crosses were as good as or better than their both grand parents or/and their third parent. The mean squares of genotypes were highly significant for all studied traits. From the analyses of F_2 triallel crosses, the parental lines Giza 86 (P_1) and Suvin (P_3) were the best combiners as a grand parent and/or parent for all studied traits except fiber fineness property. On the other hand, the variety Giza 89 (P_5) was the best combiner as a grand parent for fiber fineness (F.F.) property. Therefore, these parental genotypes could be utilized in a breeding program to improve these traits through selection in the segregating generations.

The results also investigated that the crosses (P_1 x P_3) x P_4 , (P_1 x P_5) x P_2, (P_2 x P_5) x P_4, (P_3 x P_5) x P_4 and (P_3 x P_4) x P_2 would be the best for all studied yield traits and upper half mean (UHM) property. Meanwhile, (P_1 x P_2) x P_4, (P_1 x P_5) x P_4 and (P_2 x P_3) x P_4 appeared to be the best promising crosses for breeding toward all studied yield traits potentiality. In addition, the combinations (P_1 x P_4) x P_5 and (P_3 x P_4) x P_5 appeared to be the best promising for all studied yield traits, fiber strength (F.S.) and upper half mean (UHM) properties.Furthermore, the combination (P_2 xP_4) x P_1 appeared to be the best promising for seed cotton yield/plant (S.C.Y./P.), lint yield per plant (L.Y./P.) and fiber fineness (F.F.) property. Most of these combinations had involved at least one of the best general combiners for yield.This indicates that predications of superior crosses based on the general combining ability effects of the parents which would be generally valid and the contribution of non-allelic interaction in the inheritance of these traits.These findings may explain the superiority of the three-way crosses over their parental lines for these traits.

Concerning epistatic variances, additive by additive genetic variances (σ^2AA), it showed positive values for all studied traits except for (F.F) property. While, additive by dominance genetic variances (σ^2AD) played the major role in controlling the inheritance of the studied characters of the triallel crosses. Therefore, recurrent selection might be useful in improving the studied characters of the triallel crosses in the breeding programs. The results also cleared that the calculated values of heritability in narrow sense ranged from 39.43% to 55.19% for seed cotton yield/plant (S.C.Y./P.) and fiber fineness (F.S.), respectively.

Keyword : Cotton , Triallel analysis , Gene action and Combining ability

INTRODUCTION

Recently, Egyptian cotton breeders have tried to recombine more than two parental lines through hybridization in their breeding programs. A three-way crosses or a triallel technique is a product of three parents, for instance (A x B) x C. Triallel cross system assists and enables plant breeders to obtain estimates for general combining ability (GCA) and specific combining ability (SCA). These estimates could be translated into additive and non-additive genetic variances (dominance and epistatic genetic variances). This technique also gives information on the order in which parents should be crossed for obtaining superior recombinants (Singh and Narayanan, 2000).Triallel cross analysis provides additional information about the components of epistatic variance, viz., additive x additive, additive x dominance and dominance x dominance, besides additive and dominance components of genetic variance.

Two types of general combining ability effects are worked out through triallel crosses. viz., general line effect of first kind (h_i) and general line effect of second kind (g_i). The first refers to the general combining ability effect of a line used as one of the grand parents. Whereas, the latter one refers to the general combining ability effect of a line used as parent, which was crossed to the single cross hybrid. Triallel crosses included three kinds of specific combining ability effects ; two-line specific effect of first kind (d_{ij}) refers to the specific combining ability effect of a line used as one of the grand parents (parents involved in single cross); two-line specific effect of second kind (S_{ik}), which refers to the specific combining ability of a line when crossed as a parent to the single cross; the third kind is three-line specific effect (t_{ijk}), which refers to specific combining ability effect of lines in three-way cross. These three kinds of specific combining ability effects were determined for all studied traits. Many investigators studied general and specific combining abilities among them; Patil *et al.*, (2005), Hemaida *et al*., (2006), Abd El-Bary *et a.,l* (2008), El-hoseiny (2009), Karademir *et al* (2009), Darweesh (2010), Karademir and Gencer (2010), Said (2011), El-Hashash (2012) , El-Feki *et al*., (2012).

Abd El-Maksoud *et al.*, (2003) revealed that the magnitude of additive genetic variance was positive and larger than that of dominance genetic variance with respect to all studied yield component traits. In addition, the results revealed that the three types of epistatic variance (σ^2AA, σ^2AD and σ^2DD) were contributed in the genetic expression of most studied traits except for boll weight and lint percentage. However, in another study, Yehia (2005) revealed that the magnitudes of additive genetic variances were positive and larger than these dominance genetic variances for all studied characters. In addition, the type of epistatic variances additive by dominance were positive and played the major role in inheritance of most studied traits.

The present investigation was carried out to estimate combining ability and gene action for some yield components and fiber properties using 30 F_2 three-way crosses.

MATERIALS AND METHODS

The genetic material:

The genetic material used in the present investigation included five cotton lines and their 30 F_2 three way crosses belonged to (*Gossypium barbadense*

L.).Three of them were long staple Egyptian cotton varieties: Giza 86 (P_1), Giza 85 (P_4) and Giza 89 (P_5). The other two lines were: TNB1(P_2) Sea Island an extra long staple variety and Suvin (P_3) Indian long staple germplasm.

Experimental design:

In 2010 growing season, the five parental lines and their 30 F_2 three way crosses were evaluated in a field trial experiment at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate. The experimental design was a randomized complete blocks design with three replications. Each plot was one row 4.0 m. long and 0.7 m. wide. Hills were 0.4 m. apart to insure 10 hills per row. Hills were thinned to keep a constant stand of one plant per hill at seedling stage. Ordinary cultural practices were followed as the recommendations.

Data were recorded on the following traits: boll weight in grams (B.W.g.); Seed cotton yield per plant in grams (S.C.Y. / P.g.); lint yield per plant in grams (L.Y./P.g.); lint percentage (L %) and fiber strength (F.S.), fiber fineness (F.F.) and upper half mean (UHM) as a measure of Span length in mm. The fiber properties were measured in the laboratories of Cotton Fiber Research Section, Cotton Research Institute according to (A.S.T.M.1967).

Biometrical analysis:

Statistical procedures used in this study were done according to the analysis of variance for a randomized complete blocks design as outlined by Cochran and Cox (1957). The significance was determined using the least significant difference value (L.S.D) as suggested by Steel and Torrie (1980).

The theoretical aspect of triallel analysis has been illustrated by Rawlign and Cockerham (1962), Hinkelmann (1965) and Ponnuswamy (1972) and outlined by Singh and Chaudhary (1985). Considering Y_{ijkl} as the measurement recorded on a triallel cross $G_{(ij)\,k}$, the statistical model takes the following form: $Y_{ijkl} = m + b_1 + h_i + h_j + d_{ij} + g_k + s_{ik} + s_{jk} + t_{ijk} + e_{ijkl}$

Where:

Y_{ijkl}:	Phenotypic value in the l^{th} replication on ij^{th} cross (grand parents) mated to k^{th} parent.
m:	general mean
b_l:	effects of l^{th} replication
h_i:	general line effect of i^{th} parent as grand parent (first kind general line effect)
h_j:	general line effect of j^{th} parent as grand parent (first kind general line effect)
d_{ij}:	two-line (i x j) specific effect of first kind (grand parents)
g_k:	general line effect of K as parent (second kind effect)
s_{ik}, s_{jk}:	two - line specific effect where i and j are half parents and K is the parent (specific effects of second kind)
t_{ijk}:	three-line specific effect
e_{ijkl}:	error effect

Estimation of the various effects:

(i) h_i : General line effect of first kind (grand parent). This is in fact the general combining ability effect of a line used as one of the grand parents.

$h_i = [P-1 /(rP(P-2)(P-3))] [Y_{i...} + [(P-4)/(P-1)]Y_{..i.} – [(P-4)/(P-1)] Y_{....}]$

(ii) gi :General line effect of the second kind. This refers to the general combining ability of a line used as parent which crossed to the single hybrid.

$g_i = [(P-4)/rP(P-3)][Y_{..i.} + [1/(P-2)] Y_{i...} - [1/(P-2)] Y_{....}]$

(iii) d_{ij}: Two-line specific effect of first kind (grand parents).

$$d_{ij} = \frac{P-3}{r(P-1)(P-4)}\left[Y_{ij} + \frac{1}{P-3}(Y_{i.j.} + Y_{j.i.}) - \frac{2}{P(P-3)}Y_{....} - \left(\frac{r(P^2-4+P+2)}{P-3}\right)(h_i + h_j) - \frac{r}{P-3}(g_i + g_j)\right]$$

(iv) S_{ik} = two-line specific effect where i is half parent and K is parent. (Specific effect of second kind)

$$S_{ik} = \frac{D}{D_2}\left[Y_{i.k.} + \frac{1}{D}Y_{k.i.} + \left(\frac{V-3}{D}\right)Y_{ik..} - \left(\frac{2(P-3)}{PD}\right)Y_{....} - r(P-2)h_i - \left(\frac{P-2}{D}\right)rhi - \frac{rg_i}{D} - \frac{D_1}{D}rg_j\right]$$

Where: $D = P^2 - 5P + 5$

$D_1 = P^3 - 7P^2 + 14P - 7$

and $D_2 = r(P-1)(P-3)(P-4)$.

(v) T_{ijk}: Three-line specific effect.

$$t_{ijk} = \bar{y}_{ijk} - \bar{y} - h_i - h_j - g_k - d_{ij} - S_{ik} - S_{jk}$$

Ponnuswamy *et al.* (1974) investigated that the variances and co-variances components of general effects i.e., σ^2h, σ^2g, σgh are the function of additive and additive x additive type of epistasis, whereas, σ^2d and σds are the functions of additive x additive type of epistasis only. σ^2s and σss involve dominance components while σ^2t and σtt account for epistatic components other than additive x additive.

Estimates of genetic variances:

The genetic variance components could be calculated from the previous variances using the following manner if the breeding coefficient assumed to be equal to one (F = 1).

$$\sigma^2A = \frac{1}{227F}\left[448\ \sigma^2h + 40\,\sigma^2g + 604\sigma gh - 292\sigma^2d - 584\,\sigma ds\right]$$

$$\sigma^2D = \frac{1}{127F^2}\left[416\,\sigma^2h - 352\,\sigma^2g + 496\,\sigma gh - 336\,\sigma^2d - 672\sigma ds - \frac{1816}{3}\sigma^2s + \frac{4540}{3}\sigma ss - 254\sigma^2t - \frac{3556}{3}\sigma tt\right]$$

$$\sigma^2AA = \frac{1}{227F^2}\left[-832\,\sigma^2h + 704\sigma^2g - 992\,\sigma gh + 672\,\sigma^2d + 13446\,ds\right]$$

$$\sigma^2AD = 32/3F^3\,[\sigma^2 S - \sigma ss + 4\sigma tt\ ]$$

$$\sigma^2DD = \frac{1}{3F^4}\left[-16\sigma^2s + 16\,\sigma ss + 24\,\sigma^2t - 32\,\sigma tt\right]$$

Table1: Form of the analysis of variances of the triallel crosses and the expectation of mean squares

S.O.V.	D. F	M.S	E.M.S
Replications	r-1		
Due to crosses	C-1		σ^2e + [2r /P (P-1) (P-2)-2] $\sum\sum\sum C^2_{ijK}$
Due to *h* eliminating *g*	P-1	M (h/g)	σ^2e + [rp (P-2) (P-3)/(P-1)^2] $\sum h^2_i$
Due to *g* eliminating *h*	P-1	M (g/h)	σ^2e + [rp (P-3)/(P-1)] $\sum g^2_i$
Due to *s* eliminating *d*	P^2-3P + 1	M (s/d)	σ^2e + [r/(P^2-3P + 1)] $\sum\sum S_{ij}$ [(P^2-5 P + 5) S_{ij} - S_{ji}]
Due to *d* eliminating *s*	P(P-3)/2	M (d/s)	σ^2e + [2 (P-1)(P-4)/P(P-3)^2]$\sum\sum d^2_{ij}$
Due to *t*	P(P^2-6 P + 7)/2	M (t)	σ^2e + [2r/P (P^2 – 6 P + 7)] $\sum\sum\sum t^2_{ijk}$
Error	(r-1) (C-1)	ME	σ^2e

Where: C, P and r are number of crosses, parents and replications, respectively.

The estimated heritability values in narrow sense ($h^2_{n.s.}$%) was estimated by the following equation **(Singh and Narayanan, 2000)** :

($h^2_{n.s.}$%) = (3/4 VA + 9/16 VAA) / (3/4 VA + 1/2 VD + 9/16 VAA + 3/8 VAD + 1/4 VDD + E/r)

Where: A, D, E and r are additive, dominance, error variance and replications, respectively.

RESULTS AND DISCUSSION

The mean performances of the five parental lines and their 30 F_2 three way crosses were estimated for all studied traits and the results are presented in Table 2.

The results showed that Giza 86 (P_1) was the highest yielding parent for seed cotton yield/plant (S.C.Y. /P.), lint yield/plant (L.Y. /P.), lint percentage (L. %) and boll weight (B.W.), also it was the best for fiber strength (F.S.). The parental line TNB1 (P_2) exhibited the best mean performances for all studied fiber properties and Giza 85 for fiber finesses (F.F). The parental variety Giza 89 exhibited good mean performances for seed cotton yield/plant (S.C.Y. /P.), lint yield/plant (L.Y. /P.), fiber strength (F.S.) and upper half mean (UHM). With respect to the F_2 triallel crosses, the means showed that no specific cross was superior or inferior for all studied traits. The results also revealed that the highest mean performances were found for the cross [(P_1) x (P_3)] x (P_5) for cotton yield/plant (S.C.Y. /P.) and lint yield/plant (L.Y. /P.) with the means of 319.0 g. and 132.2 g., respectively. In the same time, results showed that the cross [(P_3) x (P_5)] x (P_1) gave the highest mean for lint percentage (L. %) with mean of 41.8%.Concerning fiber properties, the results showed that the cross [(P_1) x (P_5)] x (P_3) gave the highest mean for fiber strength (F.S.) and fiber fineness (F.F) with the mean of 11.8 and 3.8, respectively. Meanwhile, the results showed that the cross [(P_1) x (P_5)] x (P_4) gave the highest mean for upper half mean (UHM) with the mean of 36.0 mm.

The analysis of variances of the slected five parents and their 30 F_2 three-way crosses were made for all studied yield and yield component traits [seed cotton yield/plant (S.C.Y./P.), lint yield/plant (L.Y./P.), boll weight (B.W.), lint percentage (L.%) and some fiber properties [fiber fineness (F.F.), fiber strength (F.S.) and upper half mean (UHM), the mean squares are presented in Table 3. The mean squares of genotypes were highly significant for all studied traits, while the parents vs. crosses mean squares showed highly significant for all studied yeild traits. Furthermore, the results indicated that the magnitudes of the crosses mean squares of all studied traits were highly significant, the partition of crosses mean squares to its components showed that the mean square due to *h* eliminating *g* and *g* eliminating *h* were highly significant for all studied traits except fiber fineness (F.F.) which had significant mean square due to *h* eliminating *g* and insignificant *g* eliminating *h*.

The estimates due to *h* eliminating *g* were larger in magnitudes than the other crosses mean squares components for seed cotton yield/plant

(S.C.Y./P.), lint yield/plant (L.Y./P.) and fiber fineness (F.F). This finding suggested that both additive and additive × additive genetic variances played a major role in the inheritance of these traits. Subsequently the selection through the advanced segregating generations of the highest yielding three-way crosses would be efficient to produce high yield lines.

In addition, the obtained results indicated that the tests of significance showed that the mean squares due to *s* eliminating *d*, *d* eliminating *s* and / or t_{ijk} were significant for most studied traits. In the same time, mean squares due to t_{ijk} were larger in magnitudes than those crosses mean squares components for lint percentage (L. %), fiber strength (F.S.) and upper half mean (U.H.M) referred to the contribution of dominance, dominance × dominance and additive ×dominance genetic variances in the genetic expression of these traits.

General combining ability effects for each parental variety:

The estimates of general combining ability effects for first kind (h_i) for parental lines were obtained for yield and yield component traits and some fiber properties as shown in Table 4. Positive estimates would indicate that a given parent is much better than the average of the group involved with it in the F_2 triallel crosses for all studied traits except fiber fineness. Comparison of the general combining ability effect (h_i) of individual parent exhibited that no parent was the best combiner as a grand parent for all yield and its component traits and/or fiber properties.

The variety Giza 86 (P_1) was the best combiner as a grand parent for boll weight (B.W.), seed cotton yield/plant (S.C.Y./P.), lint yield/plant (L.Y./P.) and upper half mean (UHM) and good combiner for fiber strength (F.S.). Whereas, the parent TNB1 (P_2) had the positive and significant values of general combining ability as a grand parent for boll weight (B.W.) and lint percentage (L. %). The parent Suvin (P_3) was a good combiner as a grand parent for seed cotton yield/plant (S.C.Y./P.) and lint yield/plant (L.Y./P.) and the best combiner as a grand parent for lint percentage (L. %) and fiber strength (F.S.). Furthermore , the results revealed that the variety Giza 85 (P_4) was the good combiner as a grand parent among this group of varieties for fiber fineness (F.F.) which had a negative (desirable) and insignificant value. On the other hand, the variety Giza 89 (P_5) was good combiner as a grand parent for upper half mean (U.H.M) and seed cotton yield/plant (S.C.Y./P.) and the best combiner as a grand parent for fiber fineness (F.F.).

The estimates of general combining ability effect of the second kind (g_i) of the parental lines were obtained for all studied yield and yield component traits and some fiber properties as shown in Table 5. The results revealed that the best combiner as the third parent in the F_2 three way crosses was Giza 86 (P_1) , which exhibited positive and highly significant (g_i) values for boll weight (B.W.), lint percentage (L. %) and upper half mean (U.H.M) and a good combiner for seed cotton yield/plant (S.C.Y./P.) and lint yield/plant (L.Y./P.), In the same time, the parent TNB1 (P_2) exhibited positive and insignificant (g_i) values for seed cotton yield/plant (S.C.Y./P.) and lint yield/plant (L.Y./P.) and fiber strength (F.S.).

Table 2 :The mean performance of the parents and thier 30 F_2 three way crosses for yield and yield component traits and some fiber properties

Genotypes	B.W.	S.C.Y./P.	L.Y./P.	L.%	F.S.	F. F	U.H.M
G.86 1	3.60	154.3	61.0	39.5	11.7	4.4	34.4
TNB1 2	3.14	130.9	49.5	37.8	11.2	3.5	34.9
Suvin 3	3.20	128.8	49.3	38.3	10.6	4.5	30.9
G.85 4	3.08	129.6	49.1	37.9	9.9	4.1	31.9
G.89 5	3.19	136.9	51.3	37.5	10.5	4.3	32.1
12 × 3	3.88	181.7	72.7	40.00	10.8	4.3	32.9
12 × 4	3.10	127.8	50.6	39.54	10.7	4.2	32.7
12 × 5	3.89	188.5	74.8	39.73	11.1	4.3	31.7
13 × 2	3.29	192.1	74.3	38.68	11.6	4.3	33.1
13 × 4	3.40	174.6	71.5	40.95	11.5	4.2	33.0
13 × 5	3.55	319.0	132.2	41.43	11.1	4.1	33.2
14 × 2	3.32	131.6	53.6	40.75	10.8	4.3	31.9
14 × 3	3.40	179.9	70.4	39.17	11.1	4.2	35.4
14 × 5	2.78	100.1	37.4	37.33	9.8	3.9	33.9
15 × 2	3.17	286.7	114.4	39.90	11.0	4.1	33.9
15 × 3	3.74	280.0	107.7	38.50	11.8	3.6	34.8
15 × 4	3.09	127.3	47.9	37.63	10.3	4.3	36.0
23 × 1	3.62	145.0	61.8	42.58	10.2	4.8	35.2
23 × 4	2.97	127.3	51.8	40.68	11.4	3.9	30.7
23 × 5	3.10	139.5	57.3	41.10	10.1	4.4	33.6
24 × 1	3.60	178.8	73.4	41.08	10.9	4.1	35.8
24 × 3	3.20	210.0	83.3	39.65	11.2	3.8	34.9
24 × 5	3.60	98.3	36.8	37.40	10.2	4.3	30.7
25 × 1	3.58	171.0	66.0	38.59	10.3	4.4	33.0
25 × 3	3.61	124.2	51.4	41.32	11.4	4.3	35.0
25 × 4	3.39	167.7	67.7	40.39	11.8	4.1	35.4
34 × 1	3.65	77.3	31.0	40.08	10.7	4.6	30.5
34 × 2	2.79	168.9	66.9	39.60	11.3	4.2	32.5
34 × 5	3.12	142.6	54.0	37.83	10.0	4.1	30.7
35 × 1	3.86	310.0	129.5	41.80	11.7	4.0	33.9
35 × 2	3.08	140.7	54.2	38.52	11.1	4.0	33.2
35 × 4	2.92	99.3	41.0	41.32	11.4	4.0	32.4
45 × 1	3.19	99.6	40.7	40.87	10.5	4.4	33.8
45 × 2	3.40	154.1	60.2	39.08	9.8	3.8	31.7
45 × 3	3.60	152.4	59.6	39.12	9.9	4.0	30.8
LSD 5%	**0.248**	**17.495**	**7.283**	**1.499**	**0.609**	**0.438**	**1.078**
LSD 1%	**0.329**	**23.268**	**9.686**	**1.994**	**0.810**	**0.583**	**1.434**

12 × 3 means (P_1 × P_2) × P_3 and so on..

The parent Suvin (P_3) was the best combiner for seed cotton yield/plant (S.C.Y./P.) and lint yield/plant (L.Y./P.) and a good combiner for boll weight (B.W.) and upper half mean (UHM). On the other hand, Giza 85(P_4) was a good combiner as a parent for fiber fineness (F.F.) and fiber strength (F.S.) which had a desierable (insignificant) values. Giza 89(P_5) was a good combiner as a parent for seed cotton yield/plant (S.C.Y./P.), lint yield/plant (L.Y./P.) and fiber fineness (F.F.) which had a desierable (insignificant) values. This findings suggested that these parental varieties could be utilized in a breeding program for improving of that traits through selection in the segregating generations.

Table 3: The results of the analysis of variances and the mean squares of the five parents and their 30 F_2 triallel crosses for yield and yield component traits and some fiber properties

S O V	d f	B.W.	S.C.Y./P.	L.Y./P.	L.%	F.S.	F. F	U.H.M
Rep.	2	0.009	276.06	30.77	0.996	0.152	0.051	1.416*
Genotypes	34	0.275**	10203.68**	1750.11**	6.025**	1.110**	0.213**	7.993**
Parients	*4*	0.127**	342.20*	76.53**	1.797	1.411**	0.534**	8.839**
Par. Vr. C	*1*	0.189**	11890.13**	2671.51**	32.842**	0.072	0.086	1.692
Crosses	*29*	0.298**	11505.73**	1949.17**	5.683**	1.105**	0.173**	8.093**
Due to *h* eliminating *g*	4	0.326**	26616.19**	4509.58**	8.210**	1.585**	0.217*	8.765**
Due to *g* eliminating *h*	4	0.430**	7840.91**	1298.33**	3.237**	0.726**	0.148	3.140**
Due to *s* eliminating *d*	11	0.372**	9975.86**	1691.07**	4.582**	0.890**	0.167*	5.071**
Due to *d* eliminating *s*	5	0.260**	13844.35**	2274.40**	1.162	0.941**	0.150	6.358**
Due to *t*	5	0.044	3376.29**	664.13**	12.563**	1.659**	0.192*	19.902**
Triallel Error	58	0.025	132.93	23.15	0.812	0.142	0.077	0.493
Over all Error	68	0.023	114.772	19.891	0.843	0.139	0.072	0.436

*** & ** significant at 0.05 and .01 levels of probability, respectively.**

Table 4: General line effect (h_i) of first kind (grand parent) for yield and yield component traits and some fiber properties

Parents	B.W.	S.C.Y./P.	L.Y./P.	L.%	F.S.	F. F	U.H.M
G.86	0.123**	37.618**	14.887**	-0.160	0.142*	0.062	0.732**
TNB1	0.083**	-13.493**	-5.021**	0.401*	-0.002	0.099	0.212
Suvin	-0.052	13.663**	6.795**	0.818**	0.324**	0.040	-0.578**
G.85	-0.181**	-52.316**	-21.930**	-0.678**	-0.388**	-0.061	-0.720**
G.89	0.027	14.527**	5.269	-0.380*	-0.077	-0.140**	0.353**
S.E.	0.030	2.174	0.907	0.170	0.071	0.052	0.132

***, ** Significant at 0.05 and 0.01 levels of probability, respectively.**

Table 5: General combining ability effect (g_i) of parental lines for yield and yield component traits and some fiber properties

Parents	B.W.	S.C.Y./P	L.Y./P.	L.%	F.S.	F. F	U.H.M
G.86	0.141**	7.943**	4.020**	0.467*	-0.031	0.128*	0.425*
TNB1	-0.073*	2.864	0.810	-0.099	0.041	0.009	-0.194
Suvin	0.091*	14.170**	5.548**	0.107	0.164	-0.054	0.235*
G.85	-0.154**	-27.678**	-11.175**	-0.037	0.074	-0.039	-0.098
G.89	-0.004	2.701	0.796	-0.437**	-0.248**	-0.035	-0.368*
S.E.	0.036	2.663	1.111	0.208	0.087	0.064	0.162

***, ** Significant at 0.05 and 0.01 levels of probability, respectively.**

Two-line specific effects of first kind (d_{ij})

It refers to the specific combining ability effect of a line used as one of the grand parents (parents involved in single cross) for 30 F_2 three way crosses. The specific combining ability effects of first kind (d_{ij}) [where i and j are grand parents] for all combinations, with respect to the studied yield components traits and some fiber properties were obtained and the results are presented in Table 6.

Table 6: Specific combining ability effects (d_{ij}) of each cross for yield and yield components traits and some fiber properties

Crosses	B.W.	S.C.Y./P.	L.Y./P.	L.%	F.S.	F. F	U.H.M
d_{12}	0.117**	-19.244**	-7.957**	0.052	-0.323**	0.124	-1.963**
d_{13}	0.385**	41.449**	17.495**	0.305	0.287*	-0.007	0.250
d_{14}	-0.224**	-66.781**	-25.808**	0.561*	-0.089	0.116	1.319**
d_{15}	-0.172**	50.533**	19.284**	-0.568*	0.101	-0.143	0.713**
d_{23}	-0.344**	-43.847**	-17.968**	0.023	-0.515**	0.064	1.144**
d_{24}	0.084	84.665**	34.810**	0.134	0.683**	-0.330**	0.759**
d_{25}	0.089	-19.427**	-8.278**	-0.283	0.186	0.149	-0.085
d_{34}	-0.013	1.731	-1.170	-0.747**	0.143	0.060	-1.232**
d_{35}	0.041	11.293**	5.804**	0.499	0.208	-0.157	0.015
d_{45}	0.038	-40.374**	-16.214**	0.024	-0.681**	0.125	-0.919**
S.E.	0.045	3.328	1.389	0.260	0.109	0.080	0.203

1, 2, 3, 4 and 5: Giza 86, TNB1, Suvin , Giza 85, and Giza 89, respectively.
***, ** Significant at 0.05 and 0.01 levels of probability, respectively.**

The results cleared that no hybrids exhibited desirable and significant values for all studied traits. However, 2, 4, 4, 1, 2, 1 and 4 out of 10 combinations showed desirable and significant or highly significant specific combining ability effects (d_{ij}) values for boll weight (B.W.), seed cotton yield/plant (S.C.Y./P.), lint yield/plant (L.Y./P.), lint percentage (L. %), fiber strength (F.S.), fiber fineness (F.F.) and upper half mean (UHM), respectively. Moreover, the combination (d_{24}) showed the best values for seed cotton yield/plant (S.C.Y./P.), lint yield/plant (L.Y./P.), fiber strength (F.S.), fiber fineness (F.F.) and good combination for upper half mean (UHM). In the same time, the combinations (d_{13}) and (d_{35}) showed good values for all studied traits. Similar results were obtained by Abd El-Maksoud et al.(2003) and Yehia (2005).

Two-line specific effects of second kind (S_{ik}):

It refers to the specific combining ability effect of a line when crossed as a parent to the single cross. The specific combining ability effects of second kind (S_{ik}) [where i is a grand parent and k as a parent] for all possible combinations, with respect to the studied yield components traits and some fiber properties were obtained and the results are presented in Table 7.

The results revealed that no combination exhibited desirable significant values for all yield and yield component traits and /or fiber properties. However, it could be concluded that the combination with line 3 (Suvin) used as one of the grand parents (in single hybrid) and line 1 (Giza 86) as parent ($S_{3.1}$) gave high performance as compared to any other combinations for boll weight (B.W) and gave (desirable) and significant or highly significant estimates seed cotton yield/plant, lint yield/plant, lint percentage (L%) and upper half mean(UHM). Meanwhile, the combination ($S_{4.1}$) gave high performance as compared to any other combinations for lint percentage (L%) and upper half mean (UHM) and gave positive (desirable) significant and highly significant estimates for (B.W) and (F.S.), respectivly. Moreover, the combination ($S_{4.2}$) appeared to be the best specific combination for seed cotton yield/plant (S.C.Y./P.) and lint yield/plant (L.Y./P.) and gave (desirable) significant or highly significant estimates for (B.W), (L%), (F.F.) and (F.S.) traits. Similar results were obtained by Abd El-

Maksoud *et al*.,(2003) and Yehia (2005). Abd El-Bary *et al*., (2008), El-Feki *et al*., (2012).

Table 7: Two-line specific effects of second kind (S_{ik}) for yield and yield components traits and some fiber properties

Combinations	B.W.	S.C.Y./P.	L.Y./P.	L.%	F.S.	F. F	U.H.M
$S_{1.2}$	-0.067	-2.92	-1.137	0.470*	0.071	0.181**	-1.658**
$S_{2.1}$	0.180**	8.35**	3.365**	0.240	-0.637**	0.187**	0.702**
$S_{1.3}$	0.372**	39.69**	14.59**	-0.336	0.455**	-0.153*	0.460**
$S_{3.1}$	0.614**	30.32**	14.82**	1.054**	-0.034	0.247**	0.390*
$S_{1.4}$	-0.344**	-90.58**	-36.71**	-0.516*	-0.471**	0.111	0.748**
$S_{4.1}$	0.095*	-46.13**	-16.72**	1.463**	0.248**	0.268**	1.351**
$S_{1.5}$	-0.119**	44.87**	18.74**	-0.143	-0.020	-0.272**	-0.029
$S_{5.1}$	0.007	58.10**	24.16**	0.217	0.224*	0.051	0.266
$S_{2.3}$	-0.120**	-14.71**	-4.93**	0.613**	0.039	-0.012	1.319**
$S_{3.2}$	-0.435**	-45.55**	-21.53**	-1.791**	0.051	0.056	1.122**
$S_{2.4}$	-0.210**	32.80**	13.56**	-0.043	0.685**	-0.365**	-0.437*
$S_{4.2}$	0.087*	61.08**	26.25**	1.082**	0.371**	-0.156*	-0.286
$S_{2.5}$	0.232**	-29.66**	-12.91**	-0.698**	-0.133	0.179**	-1.366**
$S_{5.2}$	-0.051	5.65*	1.58	-0.394	-0.231*	-0.021	-0.415**
$S_{3.4}$	-0.215**	-46.6**6	-19.15**	0.269	0.330**	-0.153*	-2.001**
$S_{4.3}$	0.065	60.14**	23.40**	-0.210	0.196*	-0.029	0.222
$S_{3.5}$	-0.067	45.95**	19.61**	0.347	-0.532**	-0.090	0.224
$S_{5.3}$	0.263**	5.22	2.32*	0.617**	0.359**	-0.150*	-0.503**
$S_{4.5}$	-0.073	-43.94**	-20.36**	-2.293**	-0.898**	-0.040	-1.176**
$S_{5.4}$	-0.215**	-72.01**	-28.95**	0.053	-0.073	0.159*	1.066**
S E	0.037	2.735	1.141	0.214	0.089	0.066	0.166

1,2,3,4 and 5: Giza 86, TNB1, Suvin , Giza 85, and Giza 89, respectively.
***, ** Significant at 0.05 and 0.01 levels of probability, respectively**

Three-line specific effects (t_{ijk}):

It refers to specific combining ability effect of a line in 30 F_2 three-way crosses.The specific combining ability effects (t_{ijk}) for all possible combinations, with respect to all studied traits were obtained and the results are presented in Table 8. The results illustrated that no three-way cross exhibited desirable significant values for all yield and yield components traits and/or fiber properties. However, 14, 11, 11, 10, 9, 7 and 9 out of 30 F_2 three-way crosses showed desirable and significant specific combining ability effects (t_{ijk}) values for boll weight (B.W.), seed cotton yield/plant (S.C.Y./P.), lint yield/plant (L.Y./P.), lint percentage (L. %), fiber strength (F.S.), fiber fineness (F.F.) and upper half mean (UHM), respectively. These F_2 three-way crosses involved [(poor x poor) x poor] or [(good x good) x good] general combiner varieties, indicating the presence of important epistatic gene action.

In general, the combinations [Giza 86 (P_1) x Suvin (P_3)] x Giza 85 (P_4), [Giza 86 (P_1) x Giza 89 (P_5)] x TNB1 (P_2), [TNB1 (P_2) x Giza 89 (P_5)] x Giza 85 (P_4), [Suvin (P_3) x Giza 89 (P_5)] x Giza 85 (P_4) and [Suvin (P_3) x Giza 85 (P_4)] x TNB1 (P_2) would be the best for all studied yield traits and upper half mean (UHM) property. Meanwhile, [Giza 86 (P_1) x TNB1 (P_2)] x Giza 85 (P_4), [Giza 86 (P_1) x Giza 89 (P_5)] x Giza 85 (P_4) and [TNB1 (P_2) x Suvin (P_3)] x Giza 85 (P_4) appeared to be the best promising for breeding toward all studied yield traits potentiality.

In addition, the combinations [Giza 86 (P_1) x Giza 85 (P_4)] x Giza 89 (P_5) and [Suvin (P_3) x Giza 85 (P_4)] x Giza 89 (P_5) appeared to be the best promising for all studied yield traits, fiber strength (F.S.) and upper half mean (UHM) property properties. Furthermore, the combination [TNB1 (P_2) x Giza 85 (P_4)] x Giza 86 (P_1) appeared to be the best promising for seed cotton yield/plant (S.C.Y./P.), lint yield per plant (L.Y./P.) and fiber fineness (F.F.) property . Most of these combinations had involved at least one of the best general combiners for yield.This indicates that predications of superior crosses based on the general combining ability effects of the parents which would be generally valid and the contribution of non-allelic interaction in the inheritance of these traits.These findings may explain the superiority of the three-way crosses over their single crosses for these traits. Similar results were obtained by Abd El-Bary *et al*., (2008), El-hoseiny (2009), Said (2011), El-Feki *et al*., (2012) and El-Hashash (2012).

Table 8: Three-line specific effects (t_{ijk}) for yield and yield components traits and some fiber properties

Combinations	B.W.	S.C.Y./P.	L.Y./P.	L.%	F.S.	F. F	U.H.M
t_{123}	-0.151**	-28.89**	-10.94 **	-0.498*	-0.551**	0.109	-1.295**
t_{124}	0.127**	41.88 **	16.53 **	0.020	-0.247**	0.083	0.272
t_{125}	0.100**	-0.83	-0.15	0.891**	0.809**	-0.048	1.283**
t_{132}	0.044	-21.56 **	-9.52 **	-0.684**	-0.192*	-0.166*	0.226
t_{134}	0.292**	80.22 **	32.85 **	0.446*	0.005	-0.005	0.747**
t_{135}	-0.075	-33.78 **	-12.56 **	0.883**	0.338**	0.244**	-0.230
t_{142}	0.297**	-14.51 **	-5.93 **	-0.242	-0.156	-0.009	-0.510**
t_{143}	-0.209**	-19.12 **	-6.74 **	0.062	-0.255**	0.160*	-0.098
t_{145}	-0.104**	11.43 **	4.63 **	0.663**	0.459**	-0.061	0.976**
t_{152}	0.120**	11.86 **	7.28 **	1.209**	0.110	0.027	1.202**
t_{153}	-0.326**	-48.28 **	-20.70**	-0.597**	-0.219*	-0.014	-0.424*
t_{154}	0.459**	48.39 **	18.85 **	-0.579	-0.205*	0.081	-0.714**
t_{231}	-0.368**	-24.48 **	-10.67 **	-0.241**	0.220*	-0.164*	-0.329
t_{234}	0.504**	46.00 **	18.27 **	-0.571**	-0.387**	0.129	-0.709**
t_{235}	-0.115**	-2.36	-0.44	0.821**	0.398**	-0.015	1.083**
t_{241}	-0.164**	23.25 **	8.44 **	-0.768**	0.152	-0.341**	-0.162
t_{243}	-0.189**	-34.98 **	-15.01**	-0.535*	-0.367**	0.028	-0.293
t_{245}	0.097*	-16.19 **	-5.09 **	1.149**	0.345**	0.279**	0.127
t_{251}	-0.310**	-51.56 **	-24.00 **	-1.890**	-0.204*	-0.257**	-2.073**
t_{253}	-0.185**	-28.61 **	-10.03 **	0.424	-0.161	0.200**	0.236
t_{254}	0.408**	86.43 **	35.84 **	0.863**	0.132	0.028	1.205**
t_{341}	-0.315**	-44.41 **	-21.29 **	-2.118**	-0.371**	-0.231**	-2.335**
t_{342}	0.095*	20.92 **	11.19 **	1.194**	-0.084	0.093	1.172**
t_{345}	0.149**	8.29 **	3.77 **	1.003**	0.724**	0.034	1.318**
t_{351}	-0.282**	3.62	2.17	-0.696**	0.226*	-0.318**	-0.222
t_{352}	0.259**	-28.24**	-10.99**	0.043	-0.109	0.054	-0.337*
t_{354}	0.120**	39.60 **	15.96 **	0.281	-0.212*	0.165*	0.409*
t_{451}	-0.302**	-8.72 **	-4.40 **	-0.060	0.363**	-0.153*	-0.138
t_{452}	0.190**	-3.91	-2.04	-0.291	-0.077	-0.114	0.648**
t_{453}	-0.066	-15.47 **	-5.24 **	-0.183	-0.482**	0.184**	-1.034**
S E	0.037	2.718	1.134	0.212	0.089	0.066	0.165

1,2,3,4 and 5: Giza 86, TNB1, Suvin , Giza 85, and Giza 89, respectively.

***, ** Significant at 0.05 and 0.01 levels of probability, respectively**

Genetic parameters :

The genetic parameters were estimated and the results are presented in Table 9. The results indicated that the magnitudes of additive genetic variances (σ^2A) were positive and larger than those of dominance genetic variances (σ^2D), with respect to all studied traits. These results indicated the predominance of additive genetic variances (σ^2A) in the inheritance of these traits.

Concerning epistatic variances, additive by additive genetic variances (σ^2AA), it showed positive values for all studied traits except for (F.F) property. While, additive by dominance genetic variances (σ^2AD) showed positive and considerable magnitudes for all studied traits. It could be concluded that fiber properties and yield components traits were mainly controlled by σ^2A, σ^2AA and /or σ^2AD epistatic variances. Therefore, the breeder would design breeding programs which make use of these advantages to select superior lines from the advanced segregating generations of the high yielding three way crosses. The estimated heritability values in narrow sense ($h^2_{n.s.}$%) ranged from 39.43% to 55.19% for seed cotton yield/plant (S.C.Y./P.) and fiber strength (F.S.), respectively. These results were in common agreement with the results obtained by many authors among them Abd El-Bary *et al*., (2008), El-hoseiny (2009), Darweesh (2010) and El-Feki *et al*., (2012).

Table 9 : The estimates of genetic parameters from the F_2 three – way crosses analysis for yield and yield components traits and some fiber properties

Genetic Parameters	B.W.	S.C.Y./P.	L.Y./P.	L.%	F.S.	F. F	U.H.M
σ^2A	0.0580	3514.00	23.570	4.2450	1.5000	0.3500	0.3604
σ^2D	-0.4360	-10442.39	-1597.58	-8.8099	-2.0522	-0.1172	-14.4507
σ^2AA	0.5991	27778.00	4639.03	3.5648	1.0000	-0.0995	19.8000
σ^2AD	1.3726	74691.75	9297.48	13.7755	3.5279	0.5856	25.9543
σ^2DD	-0.2739	-3794.99	-617.69	-6.5893	-0.9997	-0.0953	-6.2248
$h^2_{n.s.}$%	42.11	39.43	42.92	48.84	55.19	51.70	53.55

REFERENCES

Abd El-Bary, A.M.R., Y.A.M. Soliman, H.M.E.Hamoud and M.A.Abou El-Yazied (2008). Triallel analysis for yield components and fiber traits in (*Gossypium barbadense*, L.). J. Agric. Sci., Mansoura Univ., (Egypt)., Vol. 33(2): 1189 – 1201.

Abd El-Maksoud,M.M.; A.A. Awad and A.M. R. Abd El-Bary (2003). Triallel analysis of some quantitatively inherited traits in *Gossypium barbadense* L. J. Agric. Sci. Mansoura Univ., vol. 28(10): 7307-7318.

A.S.T.M. (1967). American Society for Testing Materials. Part 25, Designation, D-1447-59, D-1447-60Tand D-1447-67. USA.

Cochran, W.C. and G.M. Cox (1957). Experimental design. 2nd ed., Jon Willey and Sons. New York. U.S.A.

Darweesh, A.H.M. (2010). Genetical studies on triallel crosses in cotton. M. Sc. Thesis, Fac. of Agric., Tanta Univ., Cairo, Egypt.

El-Hashash, E.F. (2012) Estimation of combining ablity effects for yield, its components and fiber qulity traits of single and double- cross hybrids in cotton. Alex. International Cotton Conf. (17-18 April 2012)vol(2): 171-196.

El-Hoseiny, H. A. (2009). Improving Egyptian cotton using double crossing technique.Ph.D. Thesis, Fac. of Agric. Al-Aaher. Univ., Egypt.

El-Feki, T.A.; H. A. El-Hoseiny, Aziza M. Sultan and M.H.M. Orabi (2012). Improving Egyptian cotton using F_2 triallel crosses. J. Agric. Sci. Mansoura Univ., 3(2): 229-239.

Hemaida,G.M.K.; H.H.El-Adly and S.A.S. Mohamed (2006) Triallel crosses analysis for some quantitative charcters in *Gossypium barbadense* L . J. Agric. Sci., Mansoura Univ, vol. 31(6): 3451-3461.

Hinkelmann, K. (1965). Partial triallel cross. Sankhya series A, 27: 173-196.

Karademir, C.; E.Karademir, R. Ekinci and O. Gencer (2009). Combining ablity estimates and heterosis for yield and fiber qulity of cotton in line x tester design. Not. Bot. Hort. Agrobot. Cluj, 37(2): 228-233

Karademir, E. and O. Gencer (2010). Combining ablity and heterosis for yield and fiber qulity properties in cotton (*G. hirsutum* L.) obtained by half diallel mating design. Not. Bot. Hort. Agrobot. Cluj, 38(1): 222-227

Patil, A.J.; L.D. Meshram and S.B. Sakhare (2005). Triallel analysis for seed cotton yield in hirsutum cotton. J. Of Maharashtra, Agric. Univ., (India)., 30(1): 15 – 18.

Ponnuswamy, K.N. (1972). Some contribution to design and analysis for diallel and triallel cross. Ph.D. Thesis, Indian Agric. Res. Statistics.

Ponnuswamy, K.N.; M.N. Das and M.I. Handoo (1974). Combining ability type analysis for triallel crosses in Maize (*Zea mays* L.). Theo. Applied Genetics, 45: 170-175.

Rawling, J.O. and C.C. Cockerham (1962). Triallel analysis. Crop Sci., 2: 228-231.

Said, S. R. N. (2011). Genetical studies on double crosses in cotton. Ph.D. Thesis, Fac. of Agric. Tanta. Univ., Egypt.

Singh, P. and S.S. Narayanan (2000). Biometrical techniques in plant breeding. Klyani Publishers, New Delhi, 2nd ed.

Singh, R.K. and B.D. Chaudhary (1985). Biometrical method in quantitative genetic analysis. Kalyani Publishers, New Delhi.

Steel, R.G.D. and J.H. Torrie (1980). Principles and procedures of statistics. McGraw Hill Book Company Inc., New York.

Yehia, W.M.B.(2005).Three-way crosses analysis of Egyption cotton (*Gossypium barbadense* L.) Ph.D. Thesis, Fac. of Agric. Mansoura, Univ., Egypt.

تحسين القطن المصرى باستحدام الجيل الثانى للهجن الثلاثية

عبدالناصر محمد رضوان عبدالبارى
معهد بحوث القطن – مركزالبحوث الزراعية – الجيزة – مصر

اشتملت الدراسة على خمس تراكيب وراثية من قطن الباربادنس هى : جيزه 86 ، TNB1 ، سيوفن ، جيزه 85 و جيزه 89. فى موسم النمو 2010 تم تقييم هذه التراكيب الوراثية المختلفة (الأباء الخمسة ، الجيل الثانى لـ30 هجين ثلاثى) بمحطة البحوث الزراعية بسخا فى تجربة مصصممة فى قطاعات كاملة العشوائية ذات ثلاث مكررات حيث تم قياس الصفات الآتية: محصول القطن الزهر للنبات ، محصول القطن الشعر للنبات ، نسبة الشعر%، وزن اللوزة ، متانة التيلة، نعومة التيلة و طول التيلة.
هذا ويمكن تلخيص النتائج المتحصل عليها من هذه الدراسة فى النقاط التالية:

- أشار اختبار معنوية التراكيب الوراثية إلى وجود اختلافا معنويا أوعالى المعنوية بين هذه التراكيب الوراثية لكل الصفات المدروسة.
- من خلال تحليل الهجن الثلاثية كان أفضل الأباء قدرة عامة على التآلف من النوع الأول (أباء الهجن الثنائية) أو القدرة العامة للتآلف من النوع الثانى (الأب الثالث) هو الاب جيزه 86 و الاب سيوفن لصفات المحصول و الجوده ' أما الصنف جيزه 89 فقد كان افضل الأباء قدرة عامة على الإئتلاف عند استخدامه كأب ثالث لصفة نعومة التيلة.
- أظهرت الهجن التالية أفضل إمكانية لاستخدامها في برامج التربية لتحسين صفات المحصول ومكوناته وفى مقدمتها محصول القطن الزهر ومحصول القطن الشعر وهذه الهجن هى: (جيزه 86 × TNB1) × جيز85، (جيزه 86 × جيز89) × جيز85 و أخيرا الهجين (TNB1× سيوفن) × جيزه 85.
- أظهرت الهجن (جيزه 86 × سيوفن) × جيز85، (جيزه 86 × جيزه 89) × TNB1 ، (TNB1× جيزه 89) × جيزه 85 ، (سيوفن × جيزه 89) × جيز85 ، (سيوفن × جيزه 85) × TNB1 افضل امكانية لإستخدامها فى تحسين صفات المحصول وطول التيلة معا.
- اوضح الهجين (جيزه 86 × جيزه 85) × جيز 89 افضل امكانية لاستخدامه فى تحسين صفات المحصول و صفة متانة التيلة، كما اظهرت النتائج امكانية استخدام الهجين (سيوفن × جيز 85) × جيز89 فى تحسين صفات المحصول و صفتى متانة التيلة و طول التيلة.
- أظهر تحليل الجيل الثانى للهجن الثلاثية أن قيم معامل التوريث فى معناه الضيق تراوحت من39.43% الى55.195% لصفتى محصول القطن الزهر للنبات و متانة التيلة على الترتيب .
- أوضحت النتائج أن قيم التباين المضيف × المضيف و التباين المضيف × السيادى تلعب دوراً هاماً فى توارث جميع الصفات المدروسة ولذلك يجب على مربى القطن أن يستخدم هذه النتائج من اجل استنباط سلالات عالية الإنتاجية من خلال تصميم برنامج انتخاب متكرر بداية من الجيل الثانى و حتى الأجيال الانعزالية المتقدمة من الهجن الثلاثية المتفوقة.

قام بتحكيم البحث

أ.د / عبد الرحيم عبد الرحيم ليله	**كلية الزراعة – جامعة المنصورة**
أ.د / حسين يحى محمد عوض	**مركز البحوث الزراعيه**